# Gasification Technology for Clean, Cost-Effective Biomass Electricity Generation

*When we make biogas, we concentrate the energy content of biomass and convert it to a substance that's broadly usable in a variety of applications. And we're doing this with greater and greater efficiency—capturing more of the energy —all the time.*

Facilities using renewable biomass to generate electricity currently produce enough power for about seven million households per year. Many more biomass generation plants are not on the public power grid, but produce electricity and heat energy for manufacturing operations, primarily in the forest products industry.

Most of these operations use boiler technology, which involves the direct combustion of biomass materials—such as switchgrass, fast-growing trees, and wood waste—to produce steam to power electric generators. For the grid-connected plants, competition from fossil fuels and the deregulation of the electric utility industry have caused the closing of some biomass power plants.

But there is a bright future for biomass-generated electricity, largely due to a technology known as gasification. This technology has been put to limited use in coal-fired plants to reduce pollution and increase the efficiency of electricity production. When adapted for biomass, gasification applies air to the feedstock in a high-temperature reactor to produce gaseous fuel, which can be used to generate electricity from standard gas turbines.

Biomass gasifiers have the potential to be up to twice as efficient as using conventional boilers to generate electricity. For even greater efficiency, heat from the gas turbine exhaust can be used to generate additional electricity with a steam cycle. These improvements in efficiency can make environmentally clean biomass energy available at costs more competitive with fossil fuels.

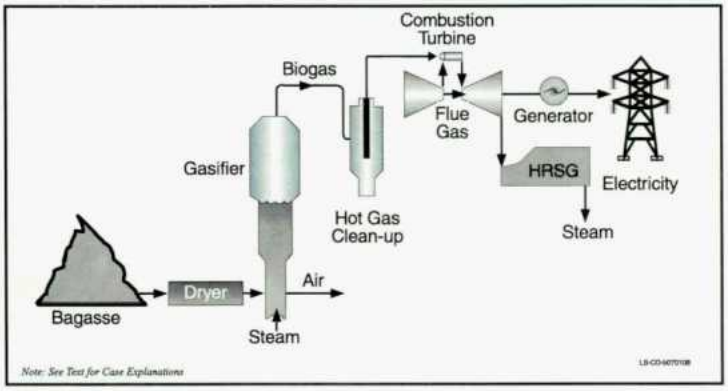
Two types of gasifiers are currently in development: direct-fired gasifiers using air, and the indirect-fired method where heated sand surrounds biomass and gasifies it.

Warren Gretz, NREL / PIX03785

Gasification systems such as this Renugas facility being demonstrated in Hawaii, can use gas turbines much like those in jet engines to generate electricity.

## Direct-fired Gasification

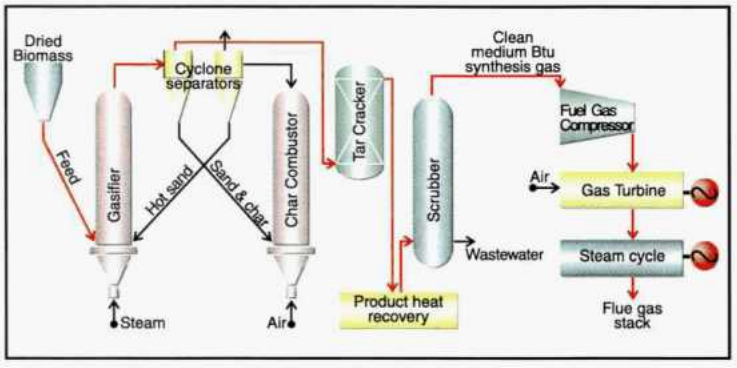
The RENUGAS® system developed by the Institute of Gas Technology (IGT) uses air to produce a low-heating-value gas. A high-pressure fluidized-bed IGT gasification system is being demonstrated at a Hawaii Commercial and Sugar Company sugar processing facility on Maui, using sugar cane processing waste, known as bagasse, as a feedstock.




While this plant currently produces electricity from agricultural residues, it is designed to accept a wide variety of biomass feedstocks.

## Indirect-fired Method

This process gasifies biomass at low pressure, using indirect gasification to produce gases with medium heating values, that is, about half that of natural gas. Thus, little or no modifications are required to the turbine combustors to burn the resulting gaseous fuels. A system based on the Battelle/Columbus indirectly fired biomass gasifier is nearing the demonstration phase at the McNeil Power Station in Burlington, Vermont.




**The Battelle/Columbus gasification system surrounds biomass particles with extremely hot sand which converts it into gaseous form.**

Solid biomass is surrounded by sand heated to 1800–1900°F, which converts the biomass into gas and residual char in a fluidized-bed reactor at 1500–1600°F. Sand is used to carry the biomass and the char and to distribute the heat. Using sand as a heat carrier keeps out the air. This results in a better quality fuel gas. A second reactor combusts the char to heat the sand. Remaining traces of condensable matter formed during gasification are removed in a chamber where a catalyst "cracks" and converts them into fuel gas. The clean biogas is then pressurized before it reaches the gas turbine.

## Gasification's Promise

Research continues to improve gasification technologies. Scientists are refining hot gas cleanup and particulate emissions control. They are studying use of power conversion technologies such as turbines and fuel cells in connection with biomass power generation. Finally, continual progress is made in lowering costs and boosting efficiencies to make biomass power generation competitive in the marketplace.

Large, commercial-scale gasifiers will use about 1,500 tons of biomass per day to generate up to 120 Megawatts of electricity, enough for about 120,000 households. Because it is a clean technology that uses renewable agricultural crops or manufacturing waste products as an energy source, gasification is ideal for community use and rural economic development. Gasifier facilities can power community growth without compromising rural residents' quality of life.

Warren Gretz, NREL / PIX00204

**Thanks to gasification technology, crops such as this switchgrass can be transformed into electricity without harming the environment.**

This document was produced for the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory.

DOE/GO-10096-349
August 1997

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste